Validation and Evaluation
of
Cognitive Architectures
Using an Emergent Combat Model

MOVES Open House
21 August 2002
Navel Postgraduate School,
Monterey, CA

MAJ Simon R. Goerger, USA
srgoerge@nps.navy.mil
(831) 656 - 3733

Ph.D. Committee

- Chair & Supervisor:
  - Dr. Rudy Darken (MOVES)   darken@nps.navy.mil
- Committee Members:
  - Dr. Michael Zyda (MOVES)   zyda@movesinstitute.org
  - COL Michael McGinnis (USMA)   fm0768@exmail.usma.army.mil
  - LTC Eugene Paulo (OR)   Paulog@trac.nps.navy.mil
  - LCDR Russ Schilling (MOVES)   rdshilli@nps.navy.mil
  - Prof John Hiles (MOVES)   jehiles@nps.navy.mil

Outline

- Issues
- Goal
- Payoffs
- Background
- Research
- Summary

Issues

Evaluation or validation for behavioral models is not well defined, nor is the current process extendable to meet requirements for validating the varied and complex behavioral models in use or under development for Department of Defense (DoD) simulations because of:

– An imperfect understanding of when a model needs to be validated or evaluated

– Limited understanding if a specific model can be validated

– Inadequate quantitative measures for validating or evaluating cognitive models

– A lack of a robust neutral environment to provide a level playing field to exercise behavioral models

– No *well-defined* process of validating or evaluating cognitive models.

Goal

To provide a means for the DoD Modeling and Simulation Community to develop standards for evaluation or validation of cognitive models for future use in legacy and emergent combat simulations involving a representation of human behavior.

Payoffs

- A link between cognitive task analysis (CTA) of real human performance to the validation processes for computational cognitive models for a combat simulation

- New referent, procedures and criteria for the evaluation and validation of cognitive models for entity level, ground combat simulations

- A set of standards for evaluating and validating cognitive models in a entity level, ground combat simulation

- A modified simulation usable for validating cognitive models in entity level, ground combat simulations

- An evaluation or validation of selected cognitive models for use in entity level, ground combat simulation

Background

- Definitions
- Model Types
- Problem Solving Process
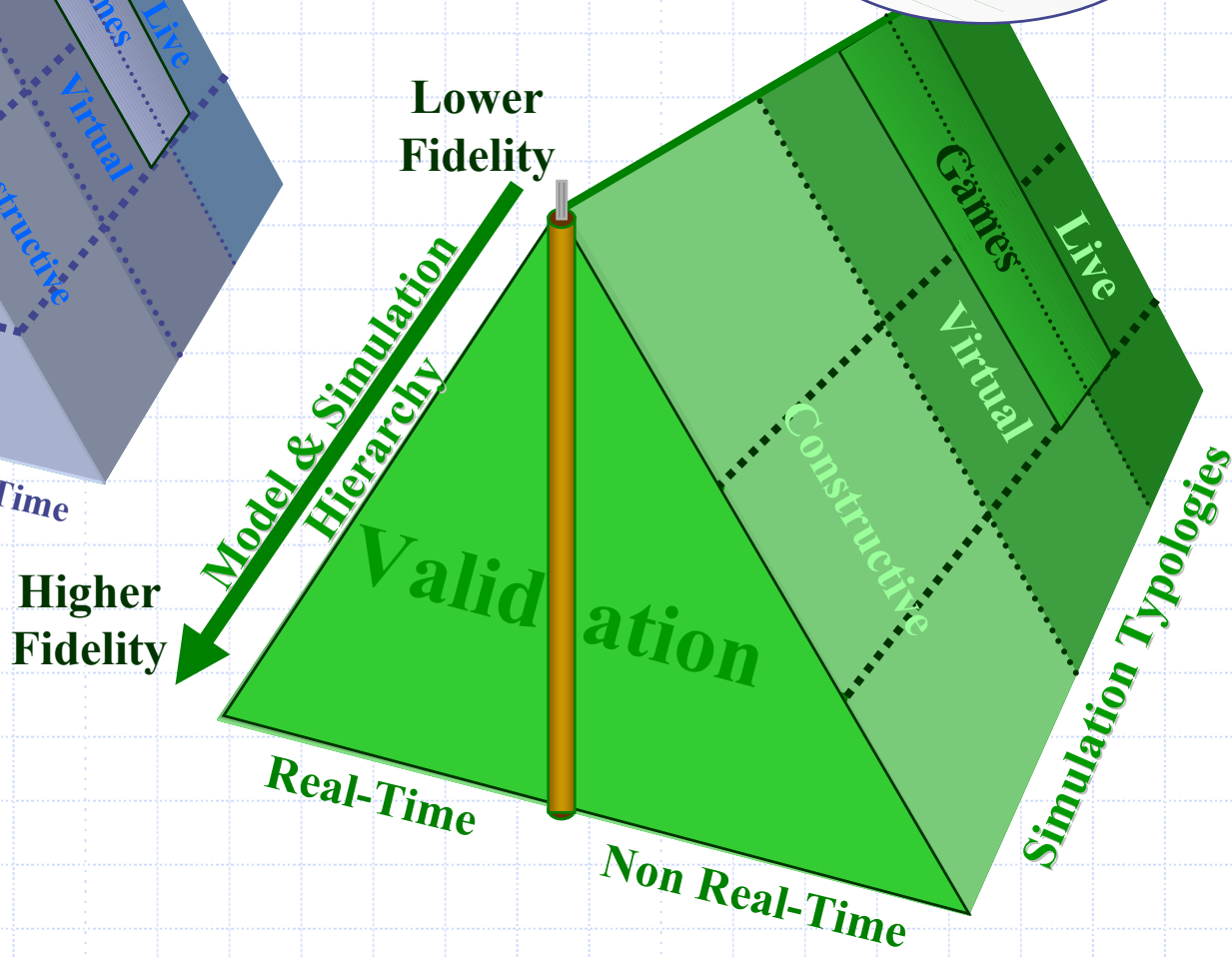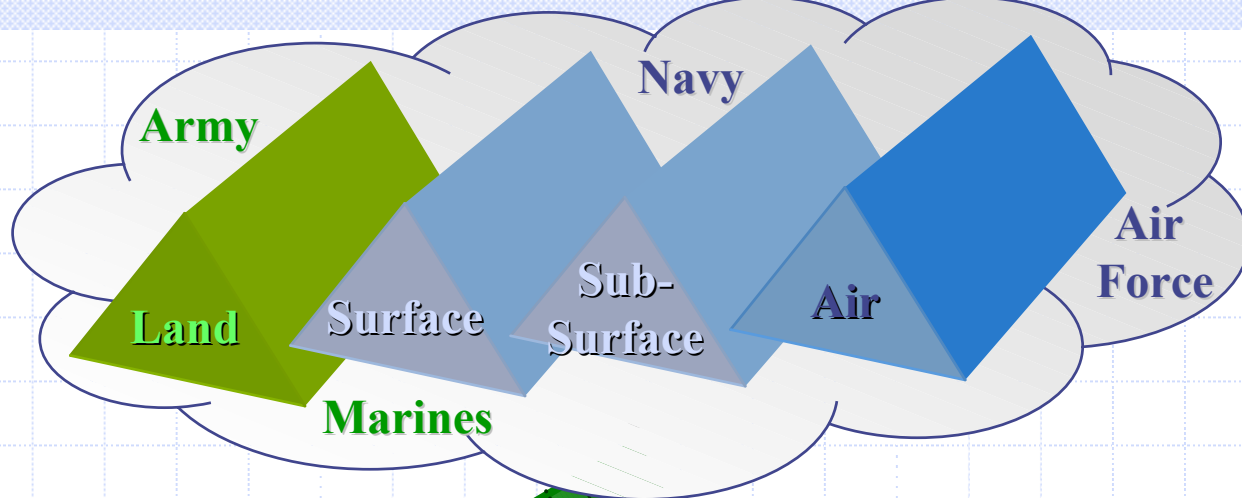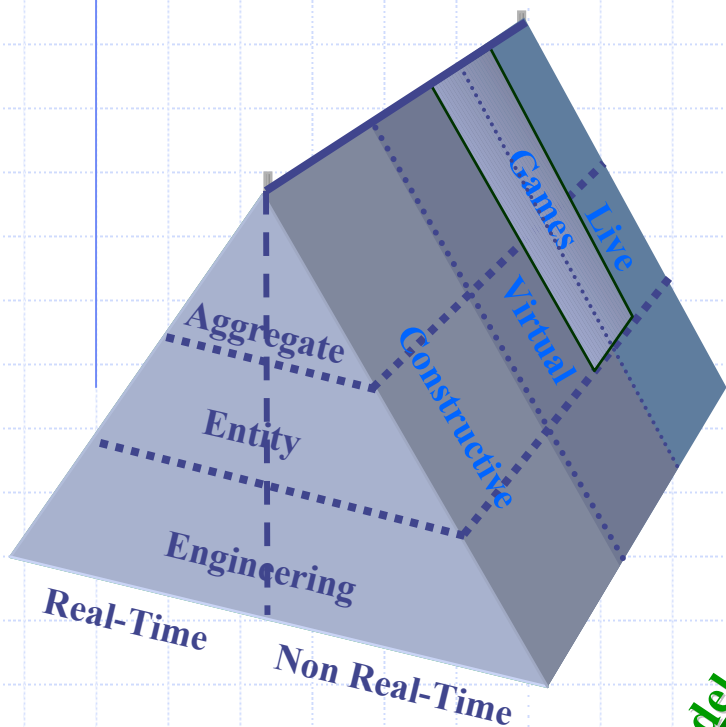- Implementation Categories for Cognitive Models

Definitions

- **Verification** – "The process of determining that a model implementation and its associated data accurately represent the developer's conceptual description and specifications." [Department of Defense Modeling and Simulation Office (DMSO)]
- **Validation** – "The process of determining the degree to which a model and its associated data provide an accurate representation of the real world from the perspective of the intended uses of the model." [DMSO]
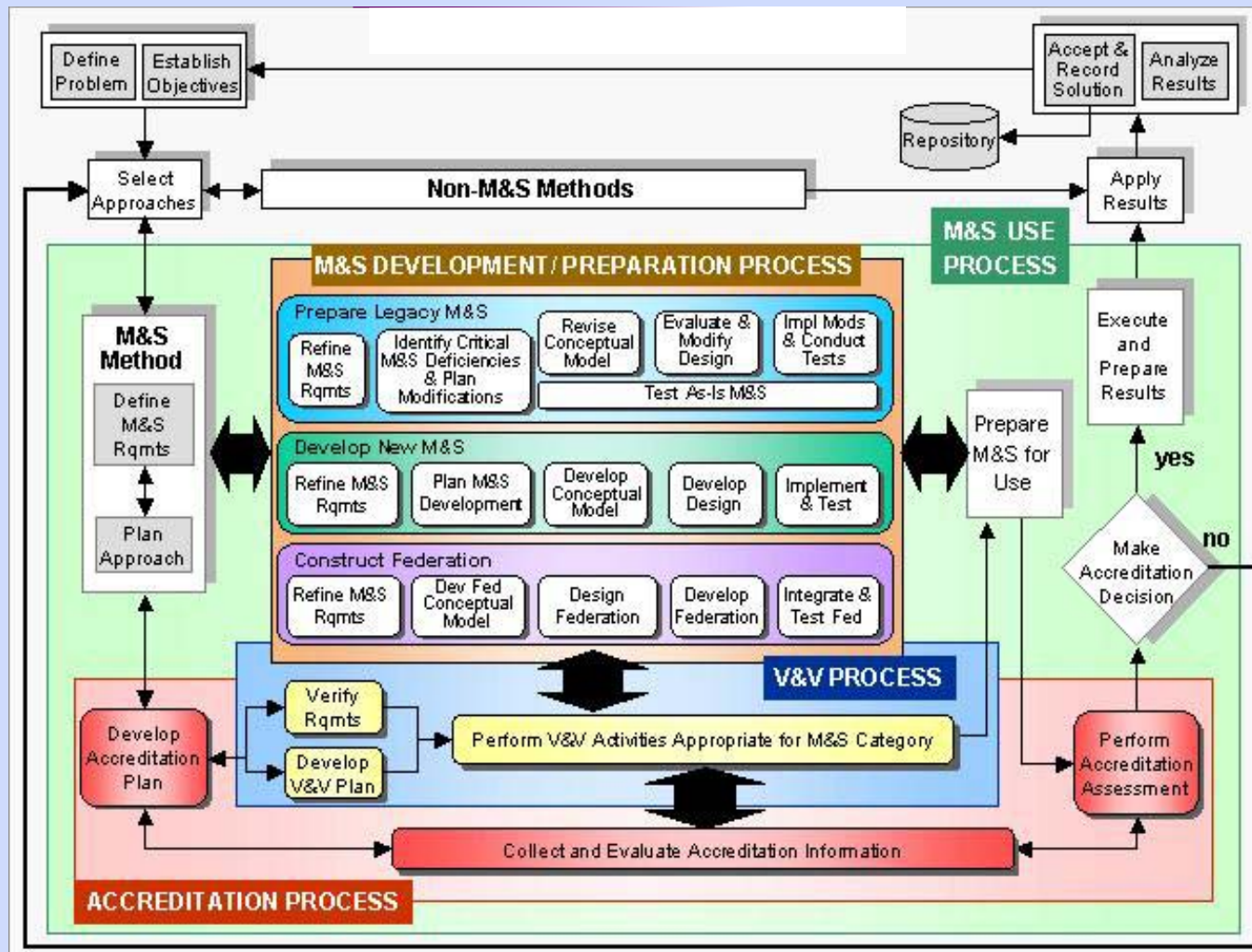
Definitions (continued)

- **Evaluation** - A means of determine how well a model agrees with the portion of the real world it is simulating. A less stringent means of agreement then validation and usually based on qualitative versus quantitative data. It is used to assess the model's quality when a model is non-predictive or non-validatable.
  [J. Hodges: Rand Corporation Report R-4114-RC/AF]
- **Accreditation** – "The official certification that a model, simulation, or federation of models and simulations and its associated data are acceptable for use for a specific purpose." [DMSO]

Model Types

Army

Navy

Air Force

Land

Surface

Sub-Surface

Air

Marines

Live

Games

Virtual

Constructive

Aggregate

Entity

Engineering

Real-Time

Non Real-Time

Lower Fidelity

Model & Simulation Hierarchy

Higher Fidelity

Validation

Live

Games

Virtual

Constructive

Simulation Typologies

Real-Time

Non Real-Time

Problem Solving Process

Department of Defense Modeling and Simulation Office (DMSO)
Verification, Validation, and Accreditation (VV&A) Recommended Practices Guide (RPG)
Reference Document (15 August 2001). "Key Concepts of VV&A"

Implementation Categories for Cognitive Models
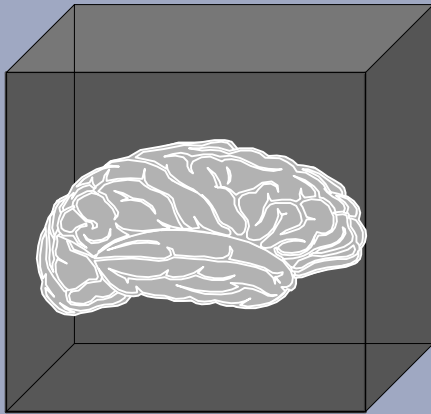
Implementation producing
  only overt behaviors:
- Rule Based Systems
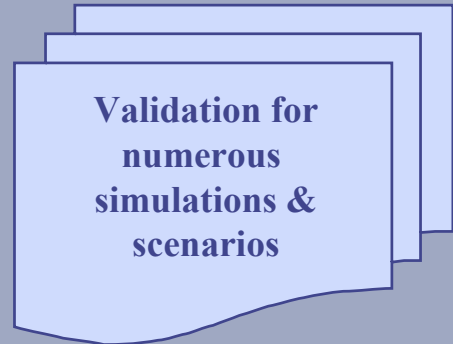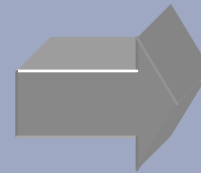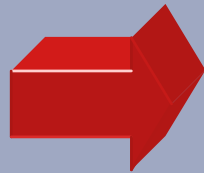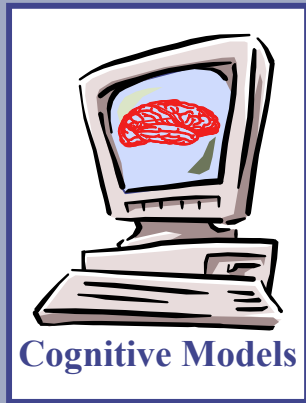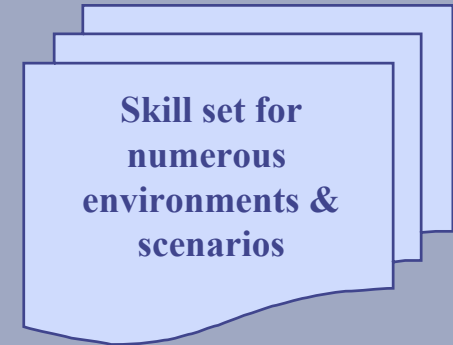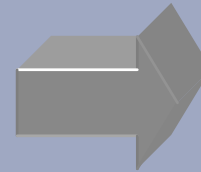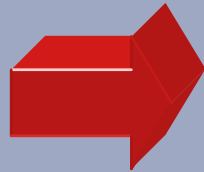- Multi-Agent Systems
  w/o Brain Lids
- Neural Networks
- Etc.
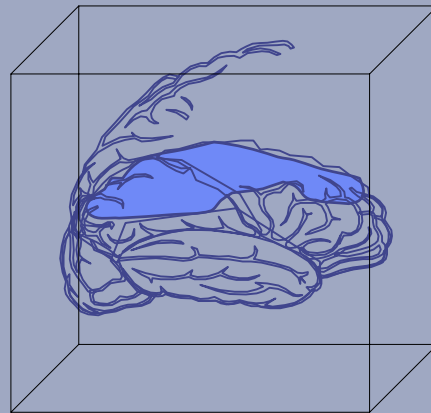
Implementation providing
  view of cognitive reasoning:
- Agents w/Brain Lids
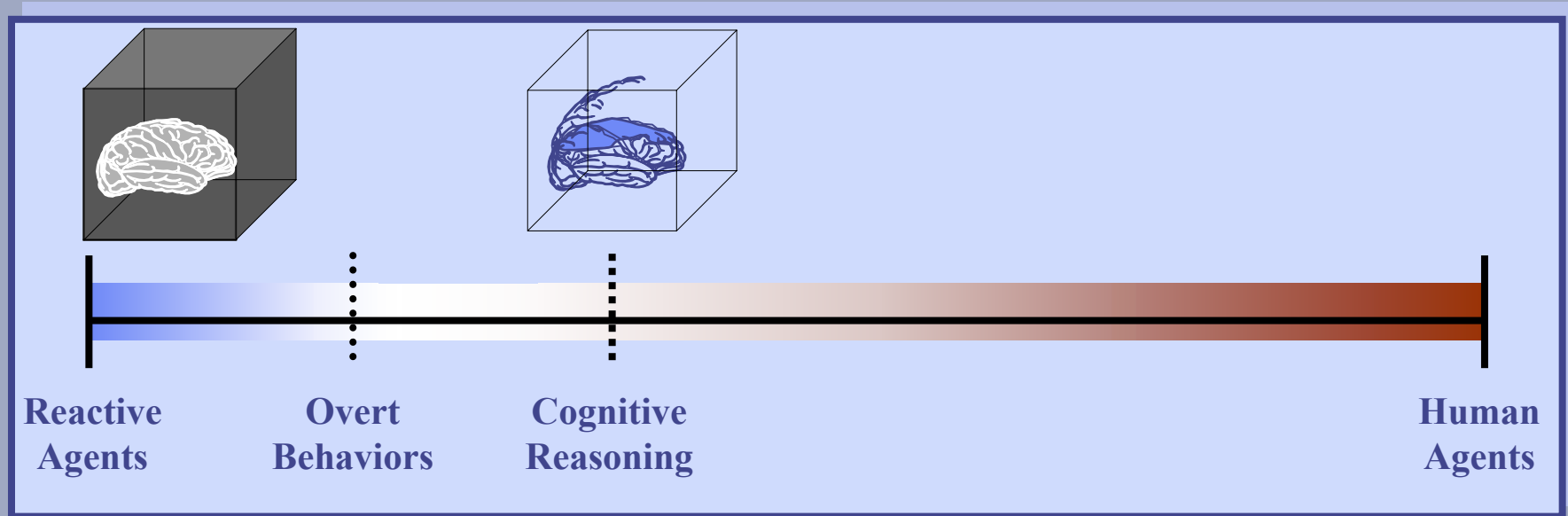- Multi-Agent Systems
  w/Brain Lids
- Etc.

Research

- Similarity of Goals
- Continuum of Cognitive Model Validation
- Verification, Validation, and Accreditation Process Modifications for Cognitive Models
- Research Vision

Similarity of Goals

Soldiers → Training → Skill set for numerous environments & scenarios

Cognitive Models → Validation Process → Validation for numerous simulations & scenarios

Continuum of Cognitive Model Validation

Reactive
Agents

Overt
Behaviors

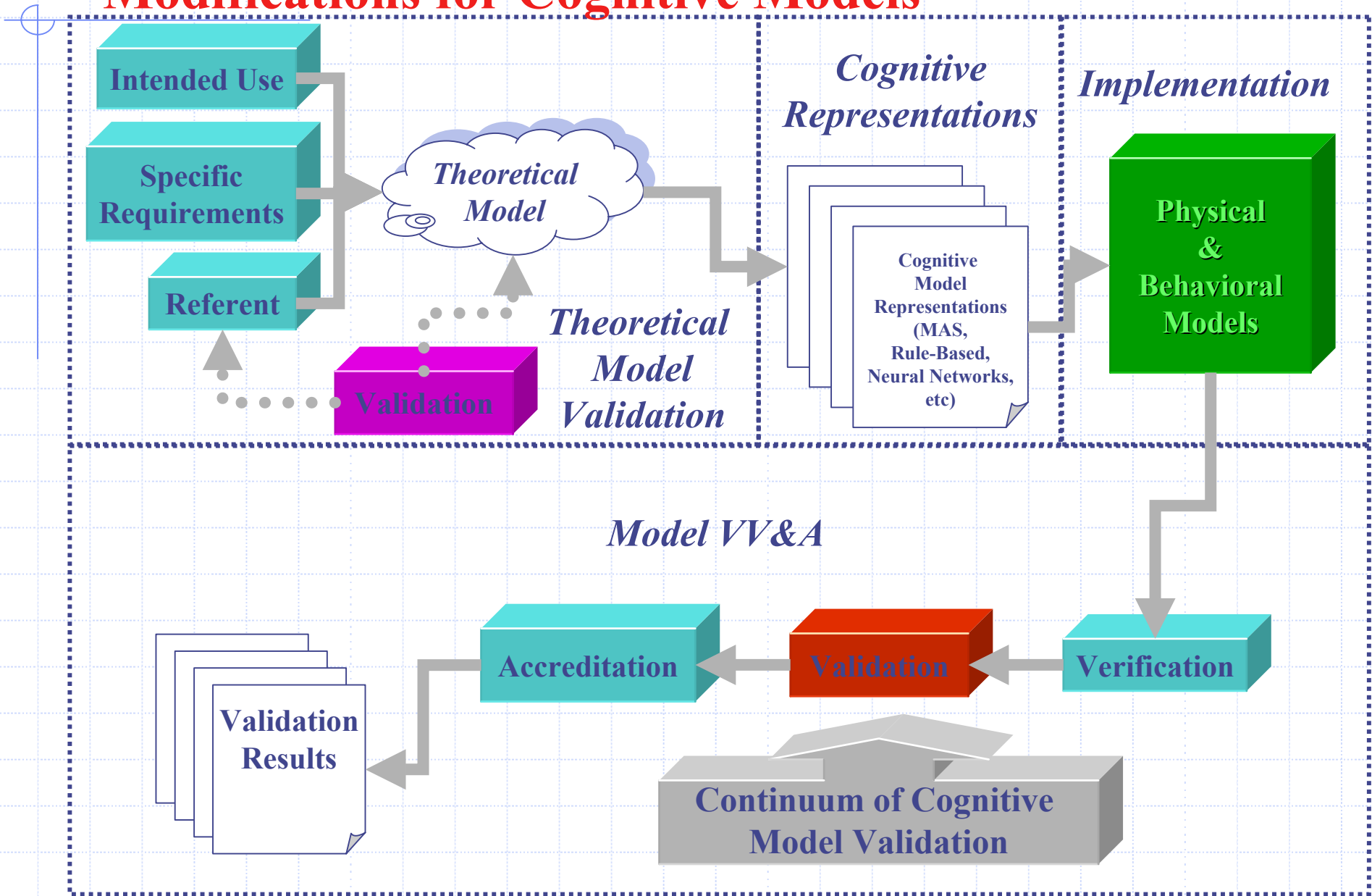Cognitive
Reasoning

Human
Agents

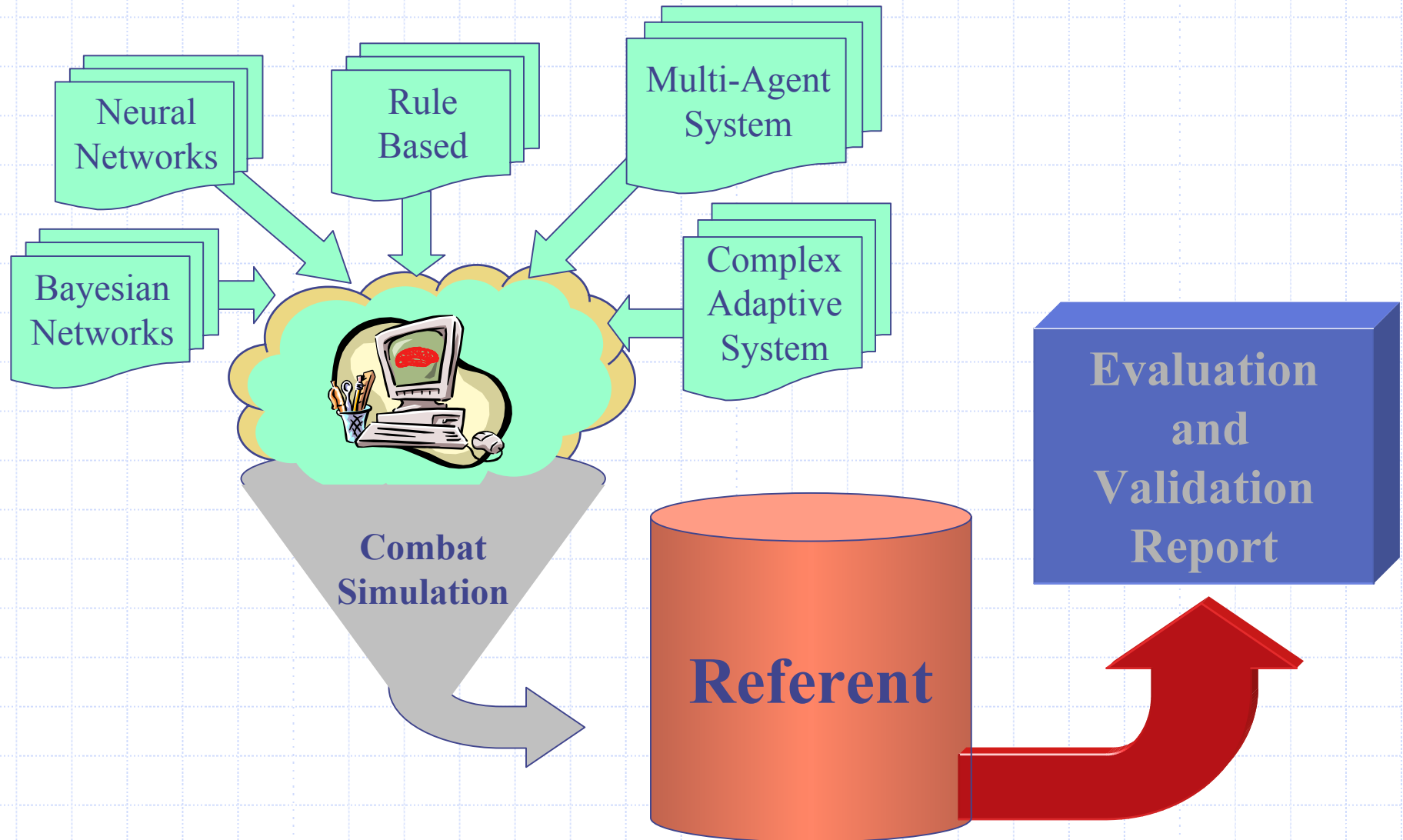- Window of Validity (Overt Behaviors)
- Window of Validity (Cognitive Reasoning)

Verification, Validation, and Accreditation Process Modifications for Cognitive Models

Research Vision

Neural Networks

Rule Based

Multi-Agent System

Bayesian Networks

Complex Adaptive System

Combat Simulation

Referent

Evaluation and Validation Report

Summary

The current evaluation and validation processes for cognitive models are inadequate for emergent DoD simulations. New means of validating these models based on cognitive reasoning as well as overt behaviors will help to ensure they are viable for use in a multitude of simulations. This will facilitate integration and use of cognitive models, increase credibility of the models, and reduce overall costs in model development.

Questions?